

# Physics

In the College of Sciences

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## Faculty

Usha S. Sinha, Ph.D., Professor of Physics, Chair of Department

Fridolin Weber, Ph.D., Albert W. Johnson Distinguished Professor of Physics, Associate Chair of Department (Graduate Adviser)

Jeffrey A. Davis, Ph.D., Professor of Physics,  
Director of Electro-Optics Program

Calvin W. Johnson, Ph.D., Professor of Physics

Alan R. Sweedler, Ph.D., Professor of Physics, Director of Center for Energy Studies, and Associate Vice President for International Programs

Milton S. Torikachvili, Ph.D., Professor of Physics

Matthew E. Anderson, Ph.D., Associate Professor of Physics  
[Senate Distinguished Professor]

Arlette R.C. Baljon, Ph.D., Associate Professor of Physics

Mauro Tambasco, Ph.D., Associate Professor of Physics

Lyuba Pavlovna Kuznetsova, Ph.D., Assistant Professor of Physics

Kenneth M. Nollett, Ph.D., Assistant Professor of Physics

Kyle Sundqvist, Ph.D., Assistant Professor of Physics

## Associateships

Graduate teaching associateships in physics are available to a limited number of qualified students. Application blanks and additional information may be secured from the chair of the department.

## General Information

The Department of Physics offers graduate study leading to the Master of Arts degree in physics, the Master of Science degree in physics, and the Master of Science degree in medical physics.

The Master of Arts degree emphasizes broad training and intensive coursework. This is a non-thesis program designed to lead the student to a comprehensive final examination. Specific courses, in both pure and applied physics, are chosen to complement the background of the individual student and achieve the desired educational goals. The program is designed to provide students with university-level teaching experience and access to community college teaching positions.

The Master of Science degree emphasizes research experience in a chosen specialty. It is designed to augment the student's undergraduate training with a core curriculum of advanced courses, then followed by a period of research and preparation of a thesis. Thesis topics are encouraged in both pure and applied areas of physics. The program is designed to provide students with university-level teaching experience and access to community college teaching positions.

Modern experimental laboratories are available for student and faculty research in the areas of modern optics, holography, optical properties of solids, laser physics, solid-state physics, nuclear magnetic resonance, electron paramagnetic resonance, atomic physics, solar energy, nuclear, medical and health physics, and image processing. Theoretical programs are available in condensed matter physics, electricity and magnetism, laser physics, nuclear and astrophysics.

The Master of Science degree in medical physics is designed to train physicists in the use of radioactive materials and radiation-producing devices such as those used in hospitals and related medical facilities, colleges and universities, industry, public health services, nuclear power installations, the military, the Department of Energy, the Environmental Protection Agency, and the Nuclear Regulatory Commission. The program emphasizes techniques of radiation dosimetry, and instrumentation in addition to the fundamental physics of radiation production and protection.

## Admission to Graduate Study

Students applying for admission should electronically submit the university application available at <http://www.calstate.edu/apply> along with the \$55 application fee.

All applicants must submit admissions materials separately to SDSU Graduate Admissions and to the Department of Physics.

### Graduate Admissions

The following materials should be submitted as a complete package directly to:

Graduate Admissions  
Enrollment Services  
San Diego State University  
San Diego, CA 92182-7416

- (1) Official transcripts (in sealed envelopes) from all postsecondary institutions attended;

NOTE:

- Students who attended SDSU need only submit transcripts for work completed since last attendance.
- Students with international coursework must submit both the official transcript and proof of degree. If documents are in a language other than English, they must be accompanied by a certified English translation.

- (2) GRE scores (<http://www.ets.org> SDSU institution code 4682);

- (3) English language score, if medium of instruction was in a language other than English (<http://www.ets.org> SDSU institution code 4682).

### Department of Physics

#### Master of Arts Degree in Physics

#### Master of Science Degrees in Physics

#### Master of Science Degree in Medical Physics

The following materials should be mailed or delivered to:

Department of Physics  
(Attention: Graduate Adviser)  
San Diego State University  
5500 Campanile Drive  
San Diego, CA 92182-1233

- (1) Letters of reference (two or three);
- (2) Application for teaching associate position or graduate assistantship (if desired).

## Master of Arts Degree and Master of Science Degree in Physics

### Admission to the Degree Curriculum

All students must satisfy the general requirements for admission to the university with classified graduate standing, as described in Part Two of this bulletin. In addition, the undergraduate preparation in physics must have substantially satisfied the undergraduate requirements for the bachelor's degree in physics. (Refer to the *General Catalog* for a description of these majors.) If the student's undergraduate preparation is deficient, he/she will be required to take courses for the removal of the deficiency. These courses are in addition to the minimum of 30 units for the master's degree.

### Advancement to Candidacy

All students must satisfy the general requirements for advancement to candidacy, as stated in Part Four of this bulletin, and satisfactory completion of Physics 604, 606, 608, and 610A.

## Specific Requirements for the Master of Arts Degree in Physics

(Major Code: 19021) (SIMS Code: 777702)

In addition to meeting the requirements for classified graduate standing, the student must satisfy the basic requirements for the master's degree as described in Part Four of this bulletin. The student's graduate program must include Physics 604, 606, 608, and 610A. Eighteen additional units of 500-, 600- or 700-numbered electives must be selected with the approval of the Physics department graduate adviser. The Master of Arts degree in physics requires the completion of Plan B, a comprehensive written examination.

## Specific Requirements for the Master of Science Degree in Physics

(Major Code: 19021) (SIMS Code: 777701)

In addition to meeting the requirements for classified graduate standing, the student must satisfy the basic requirements for the master's degree as described in Part Four of this bulletin.

The student must complete a graduate program to include Physics 604, 606, 608, 610A, 797 (3 units) and 799A. Twelve additional units of 500-, 600-, or 700-numbered electives must be selected with the approval of the Physics department graduate adviser. The student is required to pass a final oral examination on the thesis.

## Master of Science Degree in Medical Physics

### Admission to the Degree Curriculum

All students must satisfy the general requirements for admission to the Division of Graduate Affairs with classified graduate standing, as described in Part Two of this bulletin under Admission to the Division of Graduate Affairs. In addition, the undergraduate preparation in biology, chemistry, mathematics, and physics must have substantially satisfied the undergraduate requirements for a baccalaureate degree in the life sciences or the physical sciences so that satisfactory progress can be made toward the master's degree. If the student's undergraduate preparation is deficient, he will be required to take courses for the removal of the deficiency. These courses are in addition to the minimum of 30 units for the master's degree.

### Advancement to Candidacy

All students must satisfy the general requirements for advancement to candidacy, as described in Part Four of this bulletin.

## Specific Requirements for the Master of Science Degree in Medical Physics

(Major Code: 12251) (SIMS Code: 777769)

In addition to meeting the requirements for classified graduate standing and the basic requirements for the master's degree as described in Part Four of this bulletin, the student must meet the following requirements:

1. The student must complete a graduate program to include Physics 560, 565, 567, 670A, 670B. Fifteen additional units of 500-, 600-, or 700-numbered electives must be selected with the approval of the Physics department graduate adviser (maximum six units at the 500-level).
2. The thesis option (Plan A) requires the approval of the graduate adviser. Students in Plan A must include Physics 797 and Physics 799A in the 30-unit program, and are required to pass a final oral examination on the thesis.  
Students in Plan B (non-thesis option) are required to pass a comprehensive written examination.

## Residency Training in Radiation Therapy Physics Certificate

(Offered through the College of Extended Studies)  
(SIMS Code: 777740)

The advanced certificate in residency training in radiation therapy physics provides students training in clinical and didactic radiation oncology physics to attain a level of competence that they can take on the responsibilities of a radiation oncology physicist in a clinic. Students will train in the clinic in dosimetry, brachytherapy, machine quality assurance (QA) and calibration, treatment planning and dose calculations, radiation safety, imaging, and special procedures (stereotactic radiosurgery, total skin electron treatment, etc.). Training will also include acceptance testing, commissioning, quality assurance of various major clinic systems (linac, brachytherapy, treatment planning systems, etc.), and radiation safety/regulatory issues.

A student wishing to be admitted to this certificate program must meet the General Admission Requirements as described in Part Two of this bulletin. Students must meet the professional, personal, scholastic, and other standards prescribed by the appropriate department and the Graduate Council. The admission minimum requirement is a master's degree in physics or medical physics with a 3.5 GPA or better.

Required courses (36 units): Physics 701, 703, 705, and 707.

For more information, contact the physics department at <http://www.physics.sdsu.edu>.

## Courses Acceptable for Master's Degree Programs in Physics (PHYS)

*Refer to Courses and Curricula and Regulations of the Division of Graduate Affairs sections of this bulletin for explanation of the course numbering system, unit or credit hour, prerequisites, and related information.*

### UPPER DIVISION COURSES

#### PHYS 538. Polymer Science (3) (Same course as Chemistry 538)

Prerequisites: Chemistry 200 or 202; and credit or concurrent registration in Chemistry 410B or Physics 360 or Mechanical Engineering 350.

Structure, synthesis, physical properties, and utilities of polymers and biopolymers.

#### PHYS 552. Modern Optics and Lasers (3)

Prerequisites: Physics 406 with minimum grade of C; credit or concurrent registration in Physics 400B.

Electromagnetic theory, matrix methods of optics, propagation of Gaussian beams, optical resonators, interaction of radiation and atomic systems, theory of laser oscillation, nonlinear optics, specific laser systems, optical detectors, applications of lasers in physics.

#### PHYS 553. Modern Optics Laboratory (3)

One lecture and six hours of laboratory.

Prerequisites: Physics 357 with minimum grade of C; Physics 406 with minimum grade of C; credit or concurrent registration in Physics 552.

Experiments in various fields of modern optics such as holography, physics of lasers, Fourier transform spectroscopy, Raman spectroscopy, light modulation techniques, fiber optics, spatial filtering, diffraction grating spectroscopy, radiometry, and nonlinear optics.

#### PHYS 560. Radiological Physics and Dosimetry (3)

Prerequisite: Credit or concurrent registration in Physics 354.

Ionizing radiation fields, interactions of radiation with matter, cavity theory, external radiation dosimetry.

**PHYS 561. Nuclear Instrumentation (3)**

One lecture and six hours of laboratory.

Prerequisites: Physics 311 and 560.

Radiation detection, measurement, and spectroscopy. Ionization chambers, GM and proportional counters, scintillation and semiconductor detectors, and thermoluminescent dosimetry.

**PHYS 564. Nuclear Physics (3)**

Prerequisite: Credit or concurrent registration in Physics 410.

Nuclear and elementary particle phenomena including nuclear structure, decay, and radioactivity. Nuclear reactions and devices. Experimental methods and applications.

**PHYS 565. Radiobiology and Radiation Safety (3)**

Prerequisites: Credit or concurrent registration in Physics 560 and consent of instructor.

Effects of ionizing radiation on physical and biological systems in medical imaging and radiation therapy. Associated radiation safety precautions.

**PHYS 567. Nuclear Medicine Physics (3)**

Prerequisite: Physics 560.

Physical principles of nuclear medicine and operating principles of nuclear medicine instrumentation. Radionuclide production, dose calibrators, well counters, gamma cameras, SPECT, PET, image quality, tomographic reconstruction, and image processing.

**PHYS 570. Relativity (3)**

Prerequisites: Physics 354 and 400B.

Relative coordinates, Lorentz transformation, covariant formulation of the laws of physics, applications of special relativity, introduction to curved space time, cosmology.

**PHYS 580. Computational Physics (3)**

Prerequisites: Physics 354; Computer Engineering 160; and credit or concurrent registration in Physics 400A.

Computer programming for numerical solution of problems in classical mechanics, electromagnetism, optics, and quantum mechanics. Use of Fortran and C programming languages and the UNIX operating system. Incorporation of standard subroutines for linear algebra and differential equations into student written programs.

**PHYS 596. Special Topics in Physics (1-4)**

Prerequisite: Consent of instructor.

Selected topics in classical and modern physics. May be repeated with the consent of the instructor. See *Class Schedule* for specific content. Limit of nine units of any combination of 296, 496, 596 courses applicable to a bachelor's degree. Maximum credit of six units of 596 applicable to a bachelor's degree. Credit for 596 and 696 applicable to a master's degree with approval of the graduate adviser.

**GRADUATE COURSES**

**PHYS 604. Electromagnetic Theory (3)**

Prerequisite: Physics 400B.

Electrostatics, magnetic induction, and magnetostatics, Maxwell's equations, electromagnetic waves and radiation, fields in macroscopic media, special relativity.

**PHYS 606. Statistical Mechanics (3)**

Prerequisites: Physics 360, 410, 608.

Statistical basis of thermodynamics. Microcanonical, canonical, and grand canonical ensembles. Ideal Bose and Fermi systems. Interacting systems. Phase transitions.

**PHYS 608. Classical Mechanics (3)**

Prerequisites: Physics 350 and Mathematics 342B.

Vector and tensor methods, motion of rigid bodies, vibration, coupled circuits, Lagrange's and Hamilton's equations, principle of least action.

**PHYS 610A. Quantum Mechanics (3-3)**

Prerequisite: Physics 410.

Physical and mathematical basis of quantum mechanics. Wave mechanics and the Schroedinger Equation, matrices and Hilbert space, angular momentum and spin, atomic structure, bound-state perturbation theory, many particle systems, transition rates and time-dependent perturbation theory, scattering, and relativistic quantum mechanics.

**PHYS 670A-670B. Medical Physics (3-3)**

Prerequisites: Physics 560 and 561.

Radiological physics, dosimetry, imaging, and radiation protection in medical environments including diagnostic radiology, nuclear medicine, and radiation oncology.

**PHYS 672A. Radiation Therapy Physics Laboratory (3)**

One lecture and six hours of laboratory.

Prerequisite: Physics 670A.

Skills to perform radiation therapy physics procedures.

**PHYS 672B. Diagnostic Imaging Laboratory (3)**

One lecture and six hours of laboratory.

Prerequisite: Physics 670B.

Skills to perform quality assurance and acceptance testing on radiological equipment in a clinical setting.

**PHYS 674. Radiation Treatment Planning (3)**

Two lectures and three hours of laboratory.

Prerequisite: Biology 335.

Fundamental and practical concepts in radiation treatment planning. Hands on experience in clinical treatment planning for external beam radiotherapy.

**PHYS 680. Magnetic Resonance Imaging (3)**

Prerequisites: Physics 670B or Mathematics 342A and Physics 354.

Nuclear magnetic resonance, relaxation theory, Fourier transform MR imaging physics, imaging sequences, optimization of signal and contrast, special imaging sequences to include MR angiography, functional MRI, diffusion and perfusion MRI, MR hardware and configuration.

**PHYS 690. Medical Imaging Processing (3)**

Two lectures and three hours of laboratory.

Prerequisite: Physics 670B.

Digital image processing to include medical image formats, image enhancement, restoration, registration, segmentation, representation, and programming.

**PHYS 696. Advanced Topics in Physics (1-3)**

Prerequisite: Consent of instructor.

Intensive study in specific areas of physics. May be repeated with new content. See *Class Schedule* for specific content. Credit for 596 and 696 applicable to a master's degree with approval of the graduate adviser.

**PHYS 701. Clinical Rotations I (9) Cr/NC  
(Offered only in the College of Extended Studies)**

Prerequisites: Physics 564, 567, 672A, 672B.

On-site, full-day clinical training in external beam modalities (megavoltage photons, electrons, superficial x-rays) including equipment selection, radiation protection, acceptance/commissioning, calibration and quality assurance. Theoretical basis and use of the various detectors and dosimeters associated with external beam modalities.

**PHYS 703. Clinical Rotations II (9) Cr/NC  
(Offered only in the College of Extended Studies)**

Prerequisite: Physics 701.

On-site, full-day clinical training in intensity modulated radiation therapy (IMRT) and brachytherapy. Training in quality assurance, calibration, inverse planning, IMRT delivery, and radiation safety. Radionuclides and sealed sources in brachytherapy, clinical applications of the sources, treatment planning, and quality assurance.

**PHYS 705. Clinical Rotations III (9) Cr/NC  
(Offered only in the College of Extended Studies)**

Prerequisite: Physics 703.

On-site, full-day clinical training in the principles of computed tomography (CT) simulator, associated radiation protection/design considerations, CT protocols. Understand the physics of imaging modalities and perform quality assurance on CT, MRI, ultrasound and PET as related to radiation therapy. Train on picture archiving and communication systems.

**PHYS 707. Clinical Rotations IV (9) Cr/NC  
(Offered only in the College of Extended Studies)**

Prerequisite: Physics 705.

On-site, full-day clinical training covering physics concepts and implementation of standard radiation treatment (RT) techniques for common cancer treatment sites, routine quality assurance associated with patient specific RT and planning, special RT procedures, quality assurance of RT planning systems, patient safety with respect to radiation therapy.

**PHYS 797. Research (1-3) Cr/NC/RP**

Prerequisite: Consent of graduate adviser.

Research in one of the fields of physics. Maximum credit six units applicable to a master's degree.

**PHYS 798. Special Study (1-3) Cr/NC/RP**

Prerequisite: Consent of staff; to be arranged with department chair and instructor.

Individual study. Maximum credit six units applicable to a master's degree.

**PHYS 799A. Thesis (3) Cr/NC/RP**

Prerequisites: An officially appointed thesis committee and advancement to candidacy.

Preparation of a thesis in physics for the master's degree.

**PHYS 799B. Thesis Extension (0) Cr/NC**

Prerequisite: Prior registration in Thesis 799A with an assigned grade symbol of RP.

Registration required in any semester or term following assignment of RP in Course 799A in which the student expects to use the facilities and resources of the university; also student must be registered in the course when the completed thesis is granted final approval.

**PHYS 799C. Comprehensive Examination Extension (0) Cr/NC**

Prerequisite: Completion or concurrent enrollment in degree program courses.

Registration required of students whose only requirement is completion of the comprehensive examination for the master's degree. Registration in 799C limited to two semesters.

## Policy Studies in Language and Cross-Cultural Education

Refer to "Education: Dual Language and English Learner Education" in this section of the bulletin.